

## CLAIMS

What is claimed is:

1. A system for quantifying an evolution of a characteristic of a surface of an object, the system comprising:
  - an energy source for transmitting a source signal to a surface of an object for specular reflection or scattering;
  - a detector section for receiving a received signal from the surface and for providing a detector signal indicative of the received signal; and
  - a processor for receiving the detector signal from the detector section, the processor for applying an algorithm to the detector signal to quantify an evolution in a characteristic of the surface.
2. The system of claim 1 wherein the characteristic of the surface that the processor quantifies is selected from a group consisting of a defect, a slipband, a crack, a microcrack, a pit, a damage feature, corrosion, erosion, a contour change, an impact crater, and a change in residual stress.
3. The system of claim 1 wherein the energy source and the detector section are installed *in situ* with respect to the object.
4. The system of claim 1 wherein the energy source transmits the source signal over time such that the processor quantifies temporal changes in the characteristic of the surface.
5. The system of claim 4 wherein the processor also quantifies spatial changes in the characteristic of the surface.
6. The system of claim 1 wherein the detector section receives a plurality of received signals and provides a corresponding plurality of detector signals;
  - the processor for applying the algorithm to the plurality of detector signals.
7. The system of claim 6 wherein the processor determines which of the detector signals are relevant based on a parameter of the detected signals.

8. The system of claim 7 wherein the processor utilizes polarization of the detector signals to determine relevancy.

9. The system of claim 7 wherein the processor utilizes incident angle of the detector signals to determine relevancy.

10. The system of claim 7 wherein the processor utilizes wavelength of the detector signals to determine relevancy.

11. The system of claim 6 wherein the processor includes a peak detector, the processor providing a characteristic signal when a condition of the peak detector is met.

12. The system of claim 11 wherein the algorithm includes an additive function for adding the detector signals to provide a sum;  
the peak detector providing the characteristic signal when the sum meets a threshold.

13. The system of claim 11 wherein the algorithm includes an subtractive function for subtracting the detector signals to provide a difference;  
the peak detector providing the characteristic signal when the difference meets a threshold.

14. The system of claim 11 wherein the algorithm includes a multiplicative function for multiplying the detector signals to provide a product;  
the peak detector providing the characteristic signal when the product meets a threshold.

15. The system of claim 11 wherein the peak detector compares each of the detector signals to a threshold and provides a thresholded detector signal when a respective one of the detector signals meets a threshold.

16. The system of claim 15 wherein the processor applies an AND function to the thresholded detector signals and provides the characteristic signal as a result of the AND function.

17. The system of claim 15 wherein the processor applies a summation function to the thresholded detector signals and provides the characteristic signal when the result of the summation function meets a threshold.

18. The system of claim 11 further comprising a computer for receiving the characteristic signal from the processor and for processing the characteristic signal.

19. The system of claim 18 wherein the computer processes the characteristic signal in determining a failure precursor.

20. The system of claim 18 wherein the computer processes the characteristic signal in performing a damage prognosis.

21. The system of claim 18 wherein the computer processes the characteristic signal in performing a remaining-life prognosis.

22. The system of claim 1 wherein the detector section includes a plurality of detectors disposed spatially about the energy source.

23. The system of claim 1 wherein the detector section includes a plurality of detectors disposed spatially above the surface of the object.

24. The system of claim 1 wherein the detector section includes an annular detector disposed about the energy source.

25. The system of claim 1 wherein the energy source includes a light source for providing a source signal that is focused on or near the surface and has a dimension of approximately the same magnitude as that of the characteristic of the surface to be quantified.

26. A method for quantifying an evolution of a characteristic of a surface of an object, the method comprising:

transmitting a source signal to a surface of an object for specular reflection or scattering;  
detecting a received signal from the surface; and

processing a detector signal indicative of the received signal by applying an algorithm to the detector signal to quantify an evolution in a characteristic of the surface.

27. The method of claim 26 wherein the processing step includes processing the detector signal to quantify a characteristic of the surface selected from a group consisting of a defect, a slipband, a crack, a pit, a contour change, an impact crater, and residual stress.

28. The method of claim 26 wherein the transmitting step includes transmitting a source signal over time, the processing step including processing the detector signal to quantify temporal changes in the characteristic of the surface.

29. The method of claim 18 wherein the processing step includes processing the detector signal to quantify spatial changes in the characteristic of the surface.

30. The method of claim 26 wherein the receiving step includes receiving a plurality of received signals, the processing step including processing a corresponding plurality of detector signals by applying the algorithm to the plurality of detector signals.

31. The method of claim 30 wherein the processing step includes determining which of the detector signals are relevant based on a parameter of the detected signals.

32. The method of claim 30 further comprising providing a characteristic signal when at least one of the detector signals meets a condition.

33. The method of claim 32 wherein the processing step includes adding the detector signals to yield a sum, the providing step including providing the characteristic signal when the sum meets a threshold.

34. The method of claim 32 wherein the processing step includes subtracting the detector signals to yield a difference, the providing step including providing the characteristic signal when the difference meets the threshold.

35. The method of claim 32 wherein the processing step includes multiplying the detector signals to yield a product, the providing step including providing the characteristic signal when the product meets a threshold.

36. The method of claim 32 wherein the processing step includes comparing each of the detector signals to a threshold and providing a thresholded detector signal when a respective one of the detector signals meets a threshold.

37. The method of claim 36 wherein the processing step further includes applying an AND function to the thresholded detector signals, the providing step including providing the characteristic signal as a result of the AND function.

38. The method of claim 36 wherein the processing step further includes applying a summation function to the thresholded detector signals, the providing step includes providing the characteristic signal when the result of the summation function meets a threshold.

39. The method of claim 32 further comprising processing the characteristic signal.

40. The method of claim 39 wherein the processing step includes processing the characteristic signal in determining a failure precursor.

41. The method of claim 39 wherein the processing step includes processing the characteristic signal in determining a damage prognosis.

42. The method of claim 39 wherein the processing step includes processing the characteristic signal in determining a remaining-life prognosis.

43. The method of claim 26 wherein the transmitting step includes focusing a light beam on or near the surface, the light beam having a dimension that is approximately the same magnitude as that of the characteristic of the surface to be quantified.